Structural Models of the Wage Curve Estimated by Panel Data and Cross-Section Regressions

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26 February 2014

The Allocation of Non-Leisure Time and the Price of Capital:

A Model Applied Empirically to the Wage Curve[1]

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[1] The authors are grateful to Camelia Minoiu for her valuable help and Andrew Oswald for providing useful comments on the earlier draft of the paper. Emmanuel Pikoulakis would also like to thank Tassos Malliaris, George Kaufman, all the members of the Department of Economics and the Department of Finance at the Loyola University Chicago and the Department of Economics and Commerce of the University of Otago for providing most hospitable and stimulating environment during his research visits. Christopher Pissarides is also acknowledged for providing encouragement in the early stages of the paper. Authors retain all responsibility for errors and omissions.

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Abstract

Our aim in this paper is, first, to derive a model capable of explaining the stylized fact that fluctuations in labor market activities over the business cycle are primarily accommodated by changes in employment rather than in wages and, secondly, to test this model empirically. The model is simple, analytically tractable, capable of explaining a wide range of labor market behavior and, crucially, capable of explaining away real wage rigidities without resorting to market imperfections. Second, when tested empirically, the model is found to be strongly supported by the data of a diverse spectrum of economies. As it turns out, our model shares a key property with Phelps (1994) and Phelps and Zoega (1998), namely, that variations in the price of assets play a pivotal role in explaining variations in employment and in wage rates.

Keywords: Wage Curve; Price of Capital; Intratemporal and Intertemporal Substitution; Homework

JEL Codes: E22, E23, E24, J22, J23, J24

1. Introduction

The stylized fact that fluctuations in labor market activity over the business cycle are accommodated primarily by changes in employment rather than changes in real wage rates, comes by the name of real wage rigidities. Neoclassical macroeconomics maintains that such rigidities are the outcome of optimizing behavior. Building on the pioneering work of Lucas and Rapping (1969), economists in the neoclassical tradition espouse the hypothesis that workers substitute their work effort inter-temporally on the basis of the current real wage rate, the future real wage rate and the real interest rate. Economists in the New Keynesian tradition cast doubt on this scenario because, as they argue, there is not sufficient evidence to support the hypothesis that labor supply is highly elastic or that shifts in labor supply play a prominent role in business cycle fluctuations[3]. Instead, these economists attribute wage rigidities to market imperfections[4].

However, empirical findings on labor supply are likely to be biased because they do not typically allow for homework. For instance, as Rupert et al. (2000) report, omitting homework activity biases downwards the responsiveness of market hours to the real wage rate and, therefore, a model of labor supply that allows for a household sector is more likely to fit the data. To quote Benhabib *et al.* (1991): "In contrast to the standard model, which relies exclusively on inter-temporal substitution, the home production model also includes intra-temporal substitution between market work and homework at a given point in time. This makes the labor supply response in the home production economy more similar to that in the data ...". What these observations suggest is that to capture empirical responses of labor supply more accurately a researcher ought to account for the effect of homework activities. To this effect, in what follows, we shall be distinguishing between a market sector that includes all types of economic activities

[3] See Romer (1996), Sections 4.10 and 101.

[4] Please consult volumes 1 and 2 of Mankiw and Romer (1991).

recorded in the national statistics and a household sector defined to include the types of economic activities which are classified as homework and, as such, not recorded in national statistics.

With a market sector coexisting with a household sector, it would be natural to conjecture that those who are not part of the labor force as well as those who are unemployed or part-time employed spend their non-leisure time in homework or in some of the activities that define the "informal economy”. For instance, the data reported by Borland and Venn (2004) suggests that the unemployed in Australia spend approximately the same time as those who are part-time employed in activities such as domestic work, child care, voluntary work and care, and education and training. The same data also suggests that there is little difference between the unemployed and those not in the labor force as regards to the time each of these groups spends in non-market production activities and in education and training. As Greenwood and Hercowitz (1991) report: "... household activities involve approximately as much capital as business activities and three times as much (non-sleeping) time...". What these observations seem to suggest is that homework may offer an attractive alternative to full-time market work for those who are voluntarily unemployed or part-time employed. This would be particularly true if, for instance, workers have access to non-wage income. In any event, to model labor supply satisfactorily one would have to address the allocation of non-leisure time between market work and homework.

We consider two types of economic activities: an activity that specializes in the production of a single, final good, the consumption good, and an activity that specializes in installing capital broadly defined to include household capital. Firms that produce the consumption good comprise the final-goods sector which is identified with the entire market sector. Firms specializing in installing capital operate in the intermediary-goods sector. Unlike the output of the final-goods sector which is transacted entirely in the market sector, only part of the output of the intermediary-goods sector is thought to be transacted in the market since, by assumption, installing capital can involve household capital whose installation may be classified as homework. The typical agent in this model divides her entire non-leisure time between the final- goods sector and the intermediary-goods sector. To the extent that employment in the household sector is not recorded in statistics, a reallocation of labor supply from the production of the final good to the installation of capital, broadly defined to include household capital, may result in raising unemployment.

To fix ideas imagine a world dominated by small family establishments, each producing a single marketable good which can either be used for current consumption or for investment. The act of converting this good into installed capital requires time. During periods when demand for the consumption good is low some members of the family may find it profitable to reallocate some of their time in favor of installing physical and/or human capital. For instance, they may redecorate and refurbish their establishment, they may install residential capital and/or non-residential capital, and they may improve their skills through additional schooling and/or off the job training. In that scenario, periods of low measured productivity will be associated with labor hours being reallocated from the provision of current marketable goods and services to the provision of services that increase future potential output. Taking account of the fact, as Greenwood and Hercowitz (op.cit) observe, that household activities require as much capital as business activities, it would not be farfetched to expect that a reallocation of non-leisure time in favor of homework activities may well be associated with a rise in the rate of unemployment- a rise that would overstate the degree of resource underutilization because those classified as unemployed are increasing value added to the economy.[5]

In a free-market economy where firms are owned by private agents, a rise in the price of capital, for instance, by boosting non-wage earnings provides an incentive for an individual to reallocate her non-leisure time from the market sector to the household sector. At the same time, a rise in the price of capital by raising the user cost of capital induces firms to reduce labor demand. Thus, other things equal, a rise in the price of capital is accommodated, primarily, by a reduction in the rate of employment without inducing any substantial variation in the wage rate. Similarly, a reduction in the price of capital is thought to be accommodated primarily by a rise in the rate of employment. This example serves to illustrate the pivotal role that variations in the price of capital play in inducing an intra-temporal substitution of labor supply capable of explaining away real-wage rigidities. The reader can find some similarity between the above reasoning and the analysis in Phelps and Zoega (1998).

But this is half of the story because a rise in the price of capital favors future consumption relative to present consumption and, thus, favors activities akin to installing capital. To the extent that homework includes activities akin to installing capital to that extent an increase in the price of capital favors a reallocation of non-leisure time in favor of homework through an inter-temporal substitution of labor supply. In short, variations in the price of capital induce intra-temporal as well

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[5] A more somber assessment is offered in Blanchard (2006) who, on page 5, observes: "One may have a relatively benign view of the shift from market to home work. The image is of a woman who decides to interrupt her career to stay home with her children, or of the man who decides to cut the grass rather than hire a gardener. But there may be more to the story. The woman who used to provide child care may have few other skills, and the same may be true for the gardener. Minimum wage or other constraints on wage may lead them to become and remain unemployed. The result in this case is less market work, more homework, and more unemployment." Minimum wage or other constraints on wage may lead them to become and remain unemployed. The result in this case is less market work, more homework, and more unemployment."

as inter-temporal substitution of labor supply effects that coincide and reinforce each other and that are capable of explaining away real wage rigidities.

The label "wage-curve" can be traced to Blanchflower and Oswald (1990, 1994, 1995) and to Phelps (1994) and Phelps and Zoega (1998). Blanchflower and Oswald, for instance, use this label to describe an empirical regularity at the local level according to which the elasticity of the wage rate with respect to the rate of unemployment is about -0.1, a small enough number to be consistent with the phenomenon of real wage rigidities. Phelps (1994) and Phelps and Zoega (1998) use the same label to describe an equilibrium locus which is upward sloping in real wage rate-employment space. As alluded above, our model, like the models described in Phelps (1994) and Phelps and Zoega (1998), emphasizes, directly or indirectly, that asset prices and the ratio of non-wage income relative to wage income play a key role in determining wages and employment. Therefore, it is not surprising that our analysis leading to the derivation of the wage-curve bears similarities with the model of the wage-curve in Phelps and Phelps and Zoega. However whilst Phelps (op.cit.) and Phelps and Zoega (op.cit) focus on deriving the equilibrium rate of unemployment our main focus is on deriving the equilibrium wage rate consistent with behavior describing an optimizing representative agent who, as it turns out, does not need to resort to "shirking".

The structure of the remainder of this paper is as follows. Section 2 describes the technologies of the final-goods sector and of the intermediary-goods sector. Section 3 describes the command optimum in a model economy where the typical agent maximizes the present value of her lifetime utility subject to the constraints of technology. Our typical agent must make two interdependent decisions: how best to allocate her consumption between the present and the future, and how best to allocate her non-leisure time between the final-goods sector and the intermediary-goods sector. In Section 4 we describe asset market equilibrium focusing particular attention on the equilibrium price of capital. In Section 5 we derive a relation that links the equilibrium price of capital to the allocation of non-leisure time across sectors. As we show, this relation leads directly to an expression that captures the spirit of Okun's law. In Section 6 we use our model to derive an expression for the equilibrium, hourly, wage-rate on the assumption that optimizing agents are operating in competitive markets. To test empirically the model derived in Section 6 we applied panel data regressions to a sample of macroeconomic data on labor market activity covering a cross-section of 20 OECD countries over a period of more than thirty years. Section 7 is devoted to describing the empirical methodology employed to test this model and to providing a comprehensive commentary on the empirical results obtained. In Section 8 we use our model to derive an alternative, simplified, version of the equilibrium wage rate that is suitable for empirical applications to developed as well as less developed economies. To estimate this wage-rate model we have applied a cross-section regression to a group of 45 economies that differ substantially in economic development. Section 9 presents a further empirical application of our model; an application which contributes to the explanation of the relative size of the informal economy. Section 10 summarizes results and concludes the paper.

2. The Production of the Final Good and the Installation of Capital

2.1 Notation

In what follows Y shall denote the output of the final–goods sector, C the units of Y consumed, I the units of Y invested, K the stock of capital, L the labor force, N the number of workers engaged in the production of Y, h the index of skills embodied in the representative agent, v the fraction of the labor force engaged in producing Y, $(1-v)$ the fraction of the labor force engaged in the intermediary-goods sector, hr the number of hours the representative agent allocates to non-leisure activities, A the index of labor-augmenting technological progress, and ω the marginal product per worker hour in the final-goods sector. We shall let $H = hNhr$ denote the number of skilled worker hours supplied in the final-goods sector and $\tilde{\omega} = \omega / Ah$ denote the marginal product per effective worker hour in that sector. To denote the growth rate of population, the growth rate of labor-augmenting technical progress, the rate of capital depreciation, and the rate of time preference we shall use $n, g,$ δ and ρ respectively.

Since by definition hr measures the hours a representative agent allocates to non-leisure activities, the remainder time (measured by 24-hr) is meant to include all types of breaks this agent can enjoy lawfully during the prescribed working time.

2.2. The Technology of Producing the Final Good

To model the production of Y it is convenient to use the version of the neoclassical production in Jones (2001) to write:

$$\begin{aligned} Y &= (AH)^{1-\alpha} K^{\alpha} = (AH)(K/AH)^{\alpha} = (AhNhr)(K/AhNhr)^{\alpha} = \\ &= (AhvLhr)(K/AhvLhr)^{\alpha} = (AhNhr)(Y/K)^{\alpha/(\alpha-1)} = (\partial Y/\partial L)L + (\partial Y/\partial K)K \end{aligned} \qquad [1]$$

To define $Y, K,$ and C in intensive form we shall employ the following expressions:

$$\tilde{y} = (Y/AhLhr), \qquad \tilde{k} = (K/AhLhr), \quad \tilde{c} = (C/AhLhr) \qquad [2]$$

Accordingly, output per hour of effective human capital, $\tilde{y}$, and its properties are described by [3] and [4] below:

$$(\tilde{y}/v) = v^{-\alpha}\tilde{k}^{a} \qquad [3]$$

$$(\partial\tilde{y}/\tilde{k}) > 0, \ \ (\partial^2\tilde{k}/\partial\tilde{k}^2) < 0, \ \ (\partial\tilde{y}/\partial\tilde{k}) \to \infty \text{ as } \tilde{k} \to 0, \ \ (\partial\tilde{y}/\tilde{k}) \to 0 \text{ as } \tilde{k} \to \infty \qquad [4]$$

2.3 The Intermediate-Goods Sector: The Technology for Installing Capital

In the Ramsey-Cass-Koopmans model the act of converting the consumption good into installed capital is costless. One-sector models with installation costs typically employ an adjustment costs technology convex in the rate of change in the firm's capital stock. Important contributions in this literature include Abel and Blanchard (1983), Eisner and Strotz (1963), Gould (1968), Hayashi (1982), Lucas (1967), Treadway (1969) and Uzawa (1969). In two-sector models the marginal cost of investment consists of two parts: the cost of diverting resources from the production of the consumption good into the production of the investment good plus an installation cost component. For instance, Mussa (1977) defines the total marginal cost (TMC) of capital accumulation in terms of foregone consumption to include two components: (a) "the internal marginal cost of investment incurred directly by consumption goods producers" and (b) "the marginal cost of diverting labor into capital goods production". He goes on to say that the latter marginal cost "may be thought of as "external" to the individual consumption goods producer, even though it is clearly internal to the economy".

In this model the opportunity cost of installing capital consists of the cost of diverting labor from the final-goods sector to the intermediate-goods sector. Each period, the intermediate-goods sector transforms I units of the final good into I units of installed capital. By assumption this sector employs only labor, and the fraction of the labor force engaged in this sector relative to the ratio of gross investment-to-capital shall be measured by σ. Thus, the activities of the intermediate-goods sector can be described by:

$$(1-v) = \sigma[(\tilde{y}-\tilde{c})/\tilde{k}] = \sigma(I/K) \qquad [5]$$

One may interpret σ as a parameter affecting the process of installing capital such that, other things equal, innovations that raise (reduce) σ are associated with a reduction (increase) in the productivity of labor in the intermediate-goods sector. A broad definition of the labor time required for installing capital would include DIY type of activities, time spent in installing consumer durable appliances, in refurbishing and decorating, and in acquiring new skills.

3. Deriving the Command Optimum

3.1. The Objective of the Central Planner

The objective of the central planner is to maximize the present (discounted) value of the utility of an infinitely lived representative agent. To fix ideas, let $U(\tilde{c})$ denote the instantaneous utility of the representative agent with the following properties:

$$U'(\tilde{c})>0,\ \ U''(\tilde{c})<0,\quad U'(\tilde{c})\to\infty \ \text{ as }\ \tilde{c}\to 0,\quad U'(\tilde{c})\to 0\ \text{ as }\ \tilde{c}\to\infty$$

The task of the central planner can now be described as follows:

Maximize:

$$\int_0^\infty U(\tilde{c})e^{-\rho t}dt \qquad [6a]$$

Subject to:

$$(\partial\tilde{k}/\partial t)=(\tilde{y}-\tilde{c})-(g+n+\delta)\tilde{k}\ , \quad \text{and} \quad (1-v)=\sigma[(\tilde{y}-\tilde{c})/\tilde{k}]$$

Where: $\tilde{y}=v^{1-\alpha}\tilde{k}^{a}$, $\tilde{k}_0$ *: given*, $0\le\tilde{c}\le\tilde{y}$

The Lagrangian for this problem is given by:

$$\Lambda=U(\tilde{c})e^{-\beta t}+\lambda(t)[(\tilde{y}-\tilde{c})-(g+n+\delta)\tilde{k}]+\mu(t)\{(1-v)-\sigma[(\tilde{y}-\tilde{c})/\tilde{k}]\} \qquad [6b]$$

The first two terms of [6b] constitute the Hamiltonian whilst the last term introduces the labor input required in the process of installing capital in the form of an equality constraint. Accordingly, the Current Value Lagrangian may be written as follows:

$$\Lambda c = U(\tilde{c}) + m_1[(\tilde{y} - \tilde{c}) - (g + n + \delta)\tilde{k}] + m_2\{(1 - v) - \sigma[(\tilde{y} - \tilde{c}) / \tilde{k}]\} = \Lambda e^{\beta t} \quad [6c]$$

Where: $m_1 = \lambda(t)e^{\beta t}$ and, $m_2 = \mu(t)e^{\beta t}$

3.2. The First-Order Conditions of the Command Optimum and the Shadow Price of Capital

Since $\tilde{c}$ lies in the interior of $(0, \tilde{y})$, v must also lie in the interior of *(0,1)*. Thus, we may assume an interior solution and express the first-order conditions as follows:

$$(\partial \Lambda c / \partial \tilde{c}) = 0 \quad [7a]$$

$$(\partial \Lambda c / \partial v) = 0 \quad [7b]$$

$$(\partial \Lambda c / \partial m_2) = 0 \quad [7c]$$

In addition, we must observe the equation of motion for the co-state variable m_1 and the state variable $\tilde{k}$ given by [7d]-[7e] below:

$$(\partial m_1 / \partial t) = \beta m_1 - (\partial \Lambda_c / \partial \tilde{k}) \quad [7d]$$

$$(\partial \tilde{k} / \partial t) = \tilde{y} - \tilde{c} - (n + \delta + g)\tilde{k} = (\partial \Lambda_c / \partial m_1) \quad [7e]$$

As Pikoulakis (1997) shows, the conditions for saddle- path stability and the Arrow sufficiency criteria for a global maximum are satisfied in this context.

The solution to [7a] and [7b] yields the following expressions:

$$U'(\tilde{c}) = m_1 - m_2(\sigma / \tilde{k}) \quad [8a]$$

$$(\partial \tilde{y} / \partial v)[m_1 - m_2(\sigma / \tilde{k})] = m_2 = (\partial \tilde{y} / \partial v)U'(\tilde{c}) \quad [8b]$$

Rearranging [8a] -[8b] we arrive at:

$$U^{\prime}(\tilde{c}) = m_1 - m_2(\sigma / \tilde{k}) = m_1 - (\partial\tilde{y} / \partial v)U^{\prime}(\tilde{c})(\sigma / \tilde{k}) \qquad [8c]$$

$$U^{\prime}(\tilde{c})\{1 + (\partial\tilde{y} / \partial v)(\sigma / \tilde{k})\} = m_1 \qquad [8d]$$

$$\{1 + (\partial\tilde{y} / \partial v)(\sigma / \tilde{k})\} = \{m_1 / U^{\prime}(\tilde{c})\} = q \qquad [8e]$$

In [8d] above, m_1 defines the shadow price of installing a unit of newly created capital measured in (current) units of utility whilst in [8e] q defines the shadow price of (gross) investment measured in (current) units of the consumption bundle. Accordingly, $q-1$ is the marginal cost of gross investment in units of the consumption bundle. To better appreciate the economics of the marginal cost of investment consider, first, manipulating [8e] and using [5] to arrive at:

$$q - 1 = (\partial\tilde{y} / \partial v)(\sigma / \tilde{k}) = [\{(\partial\tilde{y} / \partial v)v) / v\}](\sigma / \tilde{k}) = (1-\alpha)(\tilde{y} / \tilde{k})(\sigma / v) = \qquad [9a]$$

$$= (1-\alpha)(Y / I)(I / K)(\sigma / v) = (1-\alpha)(Y / I)((1-v) / v) = [(1-v) / (vI)][vL\omega hr]$$

where $(1-\alpha)$ is the fraction of Y absorbed in wages. Rearranging [9a] we shall write:

$$\{\frac{(q-1)I}{(1-v)}\} = \frac{(1-\alpha)Y}{v} = \frac{Nhr\omega}{v} \qquad [9b]$$

As [9b] makes clear, agents install gross investment to the point where the value added from such activity equals the opportunity cost of supplying labor to the final–goods sector, measured by foregone wages. Put another way, the opportunity cost of working in the final goods sector is the forgone value added from installing capital in the intermediary-goods sector.

4. Solving for the Motion of the Co-State Variable

4.1 Capital Market Equilibrium

Applying some algebra to equations [6c], [7d], [8a] and [8b] we arrive at the condition that expresses capital market equilibrium given by:

$$(\dot{q}/q) + (\pi_K / q) = \gamma(\dot{\tilde{c}}/\tilde{c}) + \rho \qquad [10]$$

In [10], above, γ the elasticity of the marginal utility of consumption and π_K is the net profit per unit of capital defined by:

$$\pi_K = \alpha(Y/K) - (I/K) \qquad [11]$$

If we were to assume that labor-augmenting technical progress is growing at an exogenously determined rate equal to g we would be able to express $\dot{\tilde{c}}/\tilde{c}$ as the difference between the growth rate of consumption per capita, $(\dot{c}/c)$, and g to write: $(\dot{\tilde{c}}/\tilde{c}) = (\dot{c}/c) - g$. Letting r denote the return on a riskless asset, consumption growth would then be described by:

$$\gamma(\dot{\tilde{c}}/\tilde{c}) = \gamma(\dot{c}/c) - \gamma g = r - \rho - \gamma g \qquad [12]$$

Substituting [12] into [10] we arrive at:

$$(\dot{q}/q) + (\pi_K / q) = r - \gamma g \qquad [13]$$

Since $(\dot{\tilde{c}}/\tilde{c}) = (\dot{q}/q) = 0$ at the steady-state, long-run equilibrium requires that:

$$r = \gamma g + \rho \qquad [14]$$

$$(\pi_K / q) = \rho \qquad [15]$$

4.2. Capital Market Equilibrium, the Price of Capital, and the Share of the Labor Force Engaged in the Intermediate-Goods Sector

Combining the definition of net profits per unit of capital in [11] with the relation between the dividend-yield and the rate of time preference in [15], we arrive at:

$$\pi_K = (\alpha Y/K) - (I/K) = \rho q \qquad [16]$$

By definition, the marginal product of capital, MPK, (to be identified with the user cost of capital) is given by:

$$MPK = (r+\delta)q = (\alpha Y / K) \quad [17a]$$

Combining [16] with [17a] we arrive at:

$$(r+\delta)q - \rho q = (I/K) = (r-\rho+\delta)q = (\gamma g+\delta)q = (\dot{K}/K) + \delta q \quad [17b]$$

Solving for q we arrive at:

$$q = [(I/K)/(\gamma g+\delta)] \quad [18]$$

Using the expression given by [5] we can link q with $(1-v)$ as follows:

$$q = [(1-v)/(\sigma(\gamma g+\delta))] \quad [19]$$

In [19], above, we have an expression that links, directly, the equilibrium price of capital with the share of labor force engaged in the intermediate-goods sector.

5. The Allocation of Non-Leisure Time, the Price of Capital, and Okun's Law

To get a further insight into the relationship between the price of capital and the allocation of non-leisure time between sectors we shall let $s \equiv (I/Y)$ define the saving rate taken to be constant, and rewrite [9b] as follows:

$$(q-1) = \{\frac{(1-v)}{v}\}\{\frac{(1-\alpha)Y}{I}\} = \{\frac{(1-v)}{v}\}\{\frac{(1-\alpha)Y}{sY}\} = \{\frac{(1-v)}{v}\}\{\frac{(1-\alpha)}{s}\} \quad [20]$$

Alternatively, and more conveniently, one can rearrange [20] to read as follows:

$$q = \{\frac{(1-v)}{v}\}\{\frac{(1-\alpha)}{s}\} + 1 \quad [21]$$

Assuming both sides of [21] are "sufficiently close" to one, we can take logarithms to arrive at:

$$\ln(q) \approx ((1-v)/v)((1-\alpha)/s) \quad [22]$$

Hitherto variations in $(1-v)$ have been identified with variations of the proportion of the labor force engaged in the intermediary-goods sectors broadly defined to include the household sector. If we were to assume that those who are not in the labor force are mainly "discouraged workers" and proceed to conjecture that the number of discouraged unemployed vary proportionately with the number of registered unemployed we would then be able to identify variations in $((1-v)/v)$ with proportional variations in the unemployment to employment ratio. Accordingly, letting u denote the unemployment rate and $(1-u)$ denote the employment rate we shall rewrite [22] as follows:

$$\ln(q) \approx \tilde{\mu}\{(u/(1-u)\}((1-\alpha)/s) \quad , \quad \tilde{\mu} > 0 \qquad [23a]$$

Applying the Δ operator to [23a] above, evaluating the resulting expression at the equilibrium rate of unemployment to be denoted by $\bar{u}$, and solving for Δu we arrive at :

$$\Delta u = [\frac{\Delta \ln q}{\tilde{\mu}((1-\alpha)/s)(1/(1-\bar{u})^2)}] \qquad [23b]$$

Observing that $MPK = (r+\delta)q = \alpha(Y/K) = \alpha(\tilde{y}/\tilde{k})$, assuming r to be constant and solving for $\Delta \ln q$ we arrive at:

$$\Delta \ln q = \Delta \ln \tilde{y} - \Delta \ln \tilde{k} = -((1-\alpha)/\alpha)\Delta \ln \tilde{y} = -((1-\alpha)/\alpha)[(\Delta \ln y) - g] \qquad [23c]$$

Substituting [23c] into [23b] we arrive at a relation given by:

$$\Delta u = [\frac{-((1-\alpha)/\alpha)[\Delta \ln y - g]}{\tilde{\mu}((1-\alpha)/s)(1/(1-\bar{u})^2)}] = -\theta[\Delta \ln y - g] \qquad [23d]$$

Clearly, [23d] describes an Okun’s Law type relation. Whether the size of θ matches the empirical values associated with the textbook relationship is an empirical matter. What the above analysis serves to re-affirm and illustrate is that the price of capital plays a pivotal role in allocating labor supply across sectors, a role which is consistent with the spirit of Okun’s Law .

6. Modeling the Competitive, Hourly, Real Wage Rate

Our purpose in this section is to derive an expression for the hourly wage rate to be estimated empirically by panel data methods. If labor markets are competitive the equilibrium, hourly, real wage rate ω is defined by:

$$\omega vLhr = \omega Nhr = (1-\alpha)Y \qquad [24]$$

Using equation [1] to substitute Y out of [24] we arrive at:

$$\omega = (1-\alpha)(Y/Nhr) = (1-\alpha)(Ah)(Y/K)^{\alpha/(\alpha-1)} \qquad [25]$$

Noting that by [17a] $MPK = (\alpha Y/K) = (r+\delta)q$, and log-linearizing [25] we shall write:

$$\ln\omega = \ln(1-\alpha) + \ln(Ah) + (\alpha/\alpha-1)\ln(MPK/\alpha) = \qquad [26]$$

$$= \ln(1-\alpha) + \ln(Ah) + (\alpha/\alpha-1)[\ln q + \ln((r+\delta)/\alpha)] = B + \ln(Ah) + (\alpha/\alpha-1)\ln q$$

where: $B = \ln(1-\alpha) + (\alpha/(\alpha-1))[\ln((r+\delta)/\alpha)]$

Using [23a] to substitute $\ln q$ out of [26], and employing subscripts to denote the *ith* cross-sectional unit at time t we shall restate [26] as follows:

$$\ln\omega_{i,t} = B_i + \ln(Ah)_{i,t} - (\alpha/s)\tilde{\mu}\{u/(1-u)\}_{i,t} \qquad [27]$$

The simplest way to model the effectiveness of human capital is to assume that it consists of the following three components: an educational attainment component, a country-specific constant, and a trend. Letting the average years of schooling control for educational attainment we shall write:

$$\ln(Ah)_{i,t} = A_{0,i} + \beta_1 t + \gamma\ln(Schooling)_{it} \qquad [28]$$

In [28] above, the constant term is meant to capture the initial stock of ideas particular to country i, the time trend is meant to allow for the growth of technical progress along the balanced growth path, and the schooling term is meant to capture differences in the level of human capital among countries. Incorporating [28] into [27] we shall write:

$$\ln \omega_{i,t} = (A_{0,i} + B_i) + \beta_1 t + \gamma \ln(Schooling)_{i,t} - ((\alpha / s)\tilde{\mu}\{u/(1-u)\}_{i,t} \qquad [29]$$

No empirical analysis of labor market activity would be complete without some explicit reference to the effects of unemployment benefits. To this effect we have used the replacement rate (see OECD 1994, Martin (1996)) to construct a variable which we label "Replacement Wage" and which is the product of the wage rate and the replacement rate divided by 100. Accordingly, [29] can be rewritten as follows:

$$\begin{aligned} \ln \omega_{i,t} &= (A_{0,i} + B_i) + \beta_1 t + \gamma \ln(Schooling)_{i,t} - (\alpha / s)\tilde{\mu}(u/(1-u))_{i,t} \\ &+ \phi \ln(\mathrm{Rep}lacement\ Wage)_{i,t} \end{aligned} \qquad [30]$$

In an economy where the agent can choose the number of hours to offer at the market place she would be more inclined to choose to be a part-time worker when there are opportunities to acquire more schooling, participate in off-the-job training schemes, or do housework. Assuming that many part-timers are attending some form of education and/or training, the higher the average level of education in an economy, the higher will be the fraction of part-timers. Moreover, to the extent that those who attend further, off-the fob training, are entitled to unemployment benefits (or to other similar type of benefits) the higher the replacement wage the bigger the inducement to choose part-time employment and, say, acquire more schooling. Both of these effects can coincide to reduce the number of labor hours supplied by the agent as well as her output. This observation suggests that we should include an interaction term between schooling and the replacement wage. Once we control for the replacement wage and average educational attainment separately, we would expect variations in the interaction term to capture, primarily**,** the effect of changes in the average number of hours of work supplied and the disruption in the productive process associated with entering and exiting the market place. Therefore, we would expect the coefficient on the interaction term between the replacement wage and schooling to be negative. These observations lead us to adopt the following specification:

$$\begin{aligned}&\ln \omega_{i,t} = (A_{0,i} + B_i) + \beta_1 t + \gamma \ln(Schooling)_{i,t} - (\alpha / s)\tilde{\mu}(u/(1-u))_{i,t} \\ &+ \phi \ln(\mathrm{Re}\, placement\, Wage)_{i,t} + \psi\{\ln(Schooling)_{it} \times \ln(\mathrm{Re}\, placementWage)\}_{it}\end{aligned} \qquad [31]$$

Equation [31] is a quasi-reduced form relationship that combines the demand and the supply sides of the labor market. To better appreciate the implications/workings of this relationship we propose to conduct a thought experiment that traces out the effects of a rise in the price of capital on labor supply. According to our earlier analysis, the impact of such a shock would be to induce agents to shift some of their labor time in favor of activities akin to installing capital. Since installation of capital can be carried out not only in the market sector but also in the household sector and since investment in the household sector exceeds investment in the market sector (see Greenwood and Hercowitz, 1991) there is also a shift of labor time from the market sector to the household sector. At the same time, the rise in the price of capital, by raising the user cost of capital, measured by $MPK = (r + \delta)q$, induces firms in the final-goods sector to reduce labor demand. Thus, one would expect measured unemployment to rise without any appreciable change in the wage rate, a result that would explain the stylized fact that fluctuations in labor market activity over the business cycle are primarily accommodated by changes in the rate of employment than changes in real wage rates.

7. The Empirical Evidence

7.1 Data and Estimation Methods

Our empirical investigation consists of applying panel data methods of estimation - fixed effects as well as random effects methods - to a sample of annual data that draws from a pool of 20 OECD countries. All countries for which data on the variables entering equation [31] could be found are included in our sample. Furthermore, the panel is unbalanced in that the period of estimation differs between the cross-sectional units depending on data availability. Our benchmark regression is a stochastic version of [31] which reads as follows:

$$\begin{aligned} ln\,\omega_{i,t} &= \beta_{0,i} + \beta_1 t + \beta_2\, ln(\,Schooling\,)_{i,t} + \beta_3\, ln(\,Replacement\,Wage\,)_{i,t} \\ &+ \beta_4\{ln(\,Schooling\,)_{it} \times \{ln(\,Replacement\,Wage\,)_{it} + \beta_5\{\,u/(1-u\,)\}_{it} + \varepsilon_{it} \end{aligned} \quad [32]$$

The ε_{it} terms, above, are assumed to be identically and independently distributed error terms with zero mean and constant variance. In fixed effects models the $\beta_{0,i}$ term captures the time-invariant differences between countries, whilst random effects models incorporate this heterogeneity into the error term. Definitions and sources of the data employed in estimating [32], and a list of the participating countries together with some summary statistics are presented in Tables I and II of the Appendix.

If heterogeneous random coefficients are present and the explanatory variables exhibit persistence, dynamic panels (unlike cross sections) are vulnerable to biases that are difficult to eliminate by instrumental variables methods (Pesaran and Smith (1995)). After estimating a static and a dynamic version of a pooled regression on labor demand, Pesaran and Smith (1995, p.100) reported: "The most obvious feature of the results is the erratic performance of the dynamic pooled model, whose estimates are very sensitive to specification." Given that our main interest is in estimating long-run equilibrium multipliers it is natural to follow the advice of Pesaran and Smith (op.cit.) and run static panel regressions.

7.2 The Regression Results

In Table III of the Appendix we report the empirical results from running random and fixed effects regressions on [32]. Since much of our focus is on the relation between the wage rate and the rate of unemployment we pay particular attention to estimating the coefficient on $u/(1-u)$ with precision. To this effect, we estimate a version where $u/(1-u)$ is lagged one period, partly because it is thought that the effect of unemployment on the real wage rate registers with a lag and partly because lagging a variable is thought to provide more consistent estimators in some cases. It is reassuring to note that all coefficient estimates are highly significant - most of them at the 1% level of significance - and they enter with the hypothesized sign. It is also interesting to note that the parameter values for the variables estimated by fixed effects methods are not too dissimilar from the parameter values obtained by random effects methods suggesting that treating the unobserved, country-specific and time-invariant heterogeneity as part of the error term does not severely bias our results. Introducing time dummies in fixed effects provides more information about the relationship and it is also a particularly robust specification. As a result, when reporting the economic significance of our empirical findings we shall be focusing attention on the regression estimates obtained by fixed effects with time dummies.

The coefficient estimate on the logarithm of the replacement wage ranges from 0.1886 in regression (5) to 0.1923 in regression (6). This means that, other things equal, a 10% increase in unemployment benefits raises the market, hourly, wage rate by nearly 2% - a rather considerable effect. However, other things are not equal since, as hypothesized above, the effect of variations in the replacement wage depends, negatively, on the level of schooling. Indeed, this hypothesis is confirmed by the coefficient estimate on the interaction term of the logarithm of the replacement wage and the logarithm of schooling, an estimate which ranges from -0.1064 in regression (5), to

- 0.1082 in regression (6).Given that the sample average for the logarithm of schooling is 2.0566, the average treatment effect (ATE) applied on the replacement wage reveals that variations in unemployment benefits - all things considered - have a very negligible effect on the market wage rate. In fact, if there is any effect at all, this is more likely to be negative as is suggested by a point estimate obtained by applying an ATE. The main implication of this finding is that in an aggregate model of the labor market, an increase in unemployment insurance interacts with the effectiveness of human capital in a way that serves to reduce not only labor supply, but also labor demand, leaving the equilibrium wage rate largely unaffected.[6]

The coefficient estimate on the logarithm of schooling, ranges from 0.3292 in regression (5) to 0.3185 in regression (6). Given that the representative agent in the sample has attained, on average, 7.8193 years of schooling the regression results suggest that, other things equal, an extra year of schooling earns a return of just a little above 4.14%. However, as hypothesized above, other things are not equal since the return on schooling depends negatively on the level of unemployment benefits proxied by the replacement wage. To reiterate, the higher the level of unemployment benefits the higher the incentive to reduce the hours offered in the market place or exit the market place, to pursue further schooling. This, in turn, would serve to disrupt the production process and, accordingly, reduce productivity and the wage rate offered by firms. Given that the coefficient estimate on the interaction term between the logarithm of schooling and the logarithm of the replacement wage ranges from -0.1064 to -0.1082 and given that the sample average for the logarithm of the replacement wage is 2.2874, the effective net return to an extra year of schooling reduces to about 1%. This result, however, should be interpreted with caution for

[6] Wight (1991) reports: "However, if taxes are less than completely experience-rated, then the system with short-time compensation encourages *underemployment,* which in this context means an inefficiently low level of hours per employed worker". Accordingly, for any given total of labor hours we would expect a higher number of employed workers and also a higher variance in the number of employed workers than in a more efficient system. This, in turn, would imply a smaller effectiveness per unit of human capital.

several reasons. Firstly, and most importantly, this estimate takes into account the cost to the society of the opportunity afforded to the individual for exiting the labor force to attain further education. Therefore it is not surprising that some of the studies conducted at the micro level report significantly higher returns to education since, by their very nature, these studies cannot capture global feedbacks. Secondly, the reported result is only a point estimate that merely records the *marginal, effective, pecuniary* return to an agent who has attained the sample average level of schooling.

Turning attention to the impact of unemployment on pay, and for the reasons indicated above, we shall take the coefficient on lagged $u/(1-u)$ to record the more precise impact of unemployment on the market wage rate. Given that this coefficient is, about, -0.89 and given that the sample average for the unemployment rate is 0.062, the elasticity of the wage rate with respect to the rate of unemployment turns out to be - 0.062. At the 99 percent confidence interval the coefficient on $u/(1-u)$ lies between -0.58 and -1.26 which, in turn, translates to a confidence interval for the elasticity of the wage rate with respect to the unemployment rate between -0.04 and -0.09. This compares rather well with the findings of Blanchflower and Oswald (1995) who, on page 165, report: "... In the countries studied in the book, the estimated unemployment elasticity of pay is approximately -0.1 ...". Given that the sample of countries, the period under investigation, the estimation methods and the level of aggregation in our analysis differ from the study of Blanchflower and Oswald, it is comforting to note that our estimates are not too far from theirs.

A possible question that can be raised at this stage is whether there is a need to apply an instrumental variables method of estimation to [32]. To this effect we applied a test advocated by Davidson and MacKinnon (1989, 1993) to check the consistency of each estimator separately. To implement this test one has to follow a two-step procedure. In the first step, the researcher regresses the explanatory variable that is potentially correlated with the error term on a set of "instruments" and collects the residuals. In the second step, the researcher runs an OLS regression with all the explanatory variables (including the variable thought to be potentially endogenous) and the residuals from the first step. If the coefficient on these residuals is statistically insignificant, one cannot reject the null hypothesis that the variable in question does not suffer from an "endogeneity bias" – i.e, a bias which is sufficiently important to render its coefficient estimate inconsistent. Suffice to say that we applied this test to all explanatory variables in [32]. Additionally, we tested for endogeneity bias by employing a Wu-Hausman test on *ln(Schooling), ln(Replacement Wage)×ln(Schooling), ln(Replacement Wage) and* $u/(1-u)$ taken as a group.[7] The results of the Davidson and MacKinnon, as well as the Wu-Hausman tests are reported in Table IV of the Appendix, whereas the definitions of the instruments together with data sources are given in Table I of the same Appendix. The test results indicate that we cannot reject the null hypothesis that the regressors in [32] (taken separately or as a group) are "exogenous" in the sense that the reported coefficient estimates are not seriously biased

8. A Wage Rate Model Applied Empirically to a Cross-Section of Developing and Highly Developed Economies

8.1 Introduction

Whilst the empirical results obtained by estimating the wage rate model derived in Section 6 are very gratifying, one may still wonder whether the fundamentals of labor market behavior elaborated in this paper are sufficiently robust to be applicable to countries that differ significantly in their stage of development. To this effect we have applied a somewhat parsimonious version of

[7] For further details on the Wu-Hausman test please consult Wu (1973) and Hausman (1978), as well as Johnston and DiNardo (1997: 257-259).

the models described in Sections 6-7 to a group of 45 countries whose economies vary significantly in terms of per-capita incomes, and proceeded to estimate this model by a cross-section regression. What follows immediately below describes that model.

8.2 The Model

Letting $w \equiv \omega hr$, define the annual real wage rate, multiplying [9b] by (v/N), noting that $(I/N) \equiv (I/K)(K/N)$, and taking logarithms, we arrive at an expression for the logarithm of the annual wage rate of the ith country at time t given by [33a] below:

$$\ln w_{it} = \ln(q-1)_{it} + \ln(K/N)_{it} + \ln(I/K)_{it} + \ln(v/(1-v))_{it} \qquad [33a]$$

Taking $v/(1-v)$ to be negatively correlated with u, we shall write:

$$\ln w_{it} = \ln(q-1)_{it} + \ln(K/N)_{it} + \ln(I/K)_{it} + \beta_1 u_{it} \qquad \beta_1 < 0, \qquad [33b]$$

To model $\ln(I/K)$ we revisit [5] to replace the unobservable $(1/\sigma)$ with a measure of education quality to be labeled eq, and to replace the unobservable $(1-v)$ with u since u and $(1-v)$ are taken to be positively correlated. Assuming (I/K) to depend positively on eq and on the interaction between eq and u we shall re-specify [5] by:

$$\ln(I/K)_{it} = \beta_2 (eq)_{it} + \beta_3 \{(eq)(u)\}_{it} \qquad \beta_2 > 0,\ \beta_3 > 0,$$

Collecting terms we arrive at the model to be estimated empirically given by:

$$\ln(w)_{it} = \ln(q-1)_{it} + \ln(K/N)_{it} + \beta_1 u_{it} + \beta_2 eq_{it} + \beta_3 \{(eq)(u)\}_{it} \qquad [33c]$$

A particularly rewarding feature of the specification expressed by [33c] is the fact that it makes explicit the role of the price of capital in determining the equilibrium real wage rate. Equally rewarding is the fact that [33c] allows the reader to disentangle and distinguish between the forces that shift the supply schedule for labor and the forces that shift the demand schedule for labor.

A rise in the price of capital, for instance, shifts the supply schedule for labor inwards: other things equal, by making investment more attractive, a rise in the price of capital requires a rise in the wage rate to allow individuals to continue supplying the same amount of labor services to the final-goods sector. Other things equal, a rise in the capital-labor ratio, (K/N), by raising the marginal product of labor, shifts out the demand schedule for labor allowing firms to raise their wage offer. Other things equal, the higher is the share of labor allocated to the intermediary- goods sector, measured by $(1-v)$, the lower the value added per unit labor engaged in that sector and, thus, the more attractive it is to work in the final-goods sector. Since a high $(1-v)$ is thought to be associated with a high rate of unemployment, other things equal a high rate of unemployment induces workers to accept a lower wage rate. Other things equal, the higher the quality of education of those engaged in the intermediate-goods sector, measured by eq, the higher is the productivity of that sector and the higher the wage rate required to maintain the given allocation of labor between sectors. Finally, the higher is the effectiveness/productivity of those engaged in the intermediary-goods sector, approximated by the interaction term $[(eq)(u)]$, the higher the value added per unit of labor time allocated in that sector requiring a higher wage rate to maintain labor market equilibrium, other things equal.

Table VI in the Appendix presents the empirical estimates derived from applying a cross-section regression to the relation described by [33c]. The footnote to the table lists the countries to which [33c] has been applied to. The list of the relevant data utilized and its sources are presented in Table V of the same Appendix.

8.3 Commenting on the Empirical Findings

Apart from the coefficient estimate on eq which is statistically insignificant, all other coefficient estimates are statistically significant at the 1% or the 5% level. They are also correctly signed, and their numerical estimates are, generally, in accord with the model's predictions and/or in accord with predictions from other studies.

Whilst the point estimate on $\ln(q-1)$ turns out to be considerably larger than its hypothesized value of unity it is comforting to note that the 95% confidence interval containing the "true" parameter value attached to $\ln(q-1)$ ranges between 0.92 and 1.9, a range that includes the hypothesized value for the alluded point estimate.

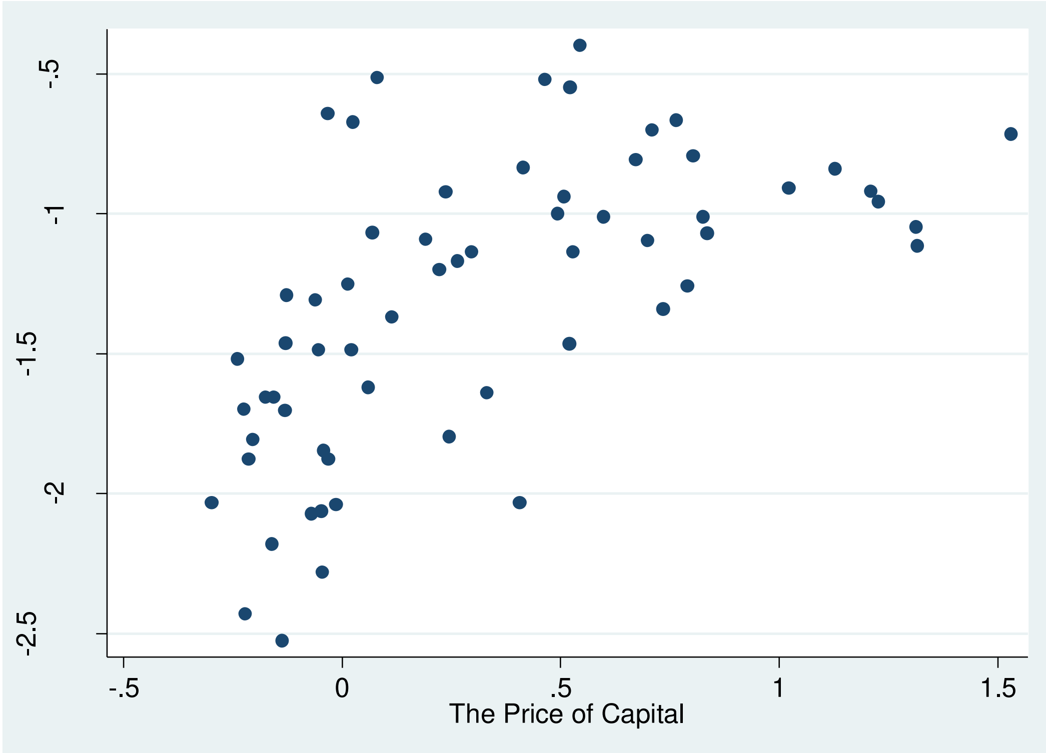
With sample averages for u and eq equal to 0.0912 and 1.0781, respectively, the estimated parameter values attached to the u and the $[(eq)(u)]$ terms imply a wage-curve elasticity of -0.1172 – a parameter value which satisfies the empirical regularity reported by Blanchflower and Oswald (op.cit.) .

The point estimate on the $[(eq)(u)]$ term together with the sample averages for u and eq reported above imply a wage rate elasticity with respect to the quality of the labor force employed in the intermediary-goods sector a little over 5. One reason that this elasticity seems exceedingly large is the fact that the sample average for the rate of unemployment is much larger than the rate one usually associates with advanced economies. A glance at the data for advanced economies suggests that the estimated parameter value for the $[(eq)(u)]$ term implies a wage rate elasticity with respect to the quality of labor in advanced economies of about 3. Nevertheless, and notwithstanding the fact the coefficient estimate on the $[(eq)(u)]$ term is not very precisely estimated, one may well argue that investing in the quality of education-particularly in less advanced economies- seems to hold the key to prosperity.

As anticipated, the elasticity of the real wage rate with respect to the capital-labor ratio, (K/N), is not significantly different from one. All in all, the above results lend further support to our model and compliment nicely the results obtained by panel data methods of estimation.

9. The Informal Economy and the Price of Capital: A Further Application

In an empirical investigation involving two cross-section regressions applied to a group of 62 countries – both developing and highly developed – Pikoulakis (2010), by deriving the exact same model described in this paper finds that, contrary to claims by Schneider (2002), neither the corporate tax rate nor the personal tax rate are statistically significant in explaining the size of the informal economy once the effects of the price of capital and the effects of geography- a variable recording the percentage of a country's land area that lies within the geographical tropics- have been controlled for. Since the price of capital has been shown to play a pivotal role in explaining the behavior of the unemployment rate and of the wage rate, we thought that it may be of interest to the reader to mention that the analysis reported in this paper equally applies to a range of diverse issues such as, for instance, the size of the informal economy. For the convenience of the reader the empirical findings on the size of the informal economy reported in Pikoulakis (op.cit.) are reproduced in Table VII of the Appendix. For a description of the data and its sources used in these regressions the reader may consult Pikoulakis (op.cit.). The diagram below is a scatter plot of data measuring the logarithm of the size of the informal economy and the logarithm of the price of capital.



10. Summary and Conclusions

What recommends the theoretical part of our paper is its simplicity, its transparency, its analytical tractability, and its ability not only to explain away real wage rate rigidities without resorting to market imperfections, but also to explain such diverse issues as Okun's Law and the size of the informal economy. The fact that the price of capital plays a pivotal role in explaining the movements in labor supply and labor demand makes the model closer in spirit with Phelps (1994) and Phelps and Zoega (1998). Also, by allowing for the presence of homework, the model brings out the fact that variations in the price of capital elicit not only inter-temporal substitution effects but also intra-temporal substitution effects which, in turn, makes it easier to explain away real wage rigidities without having to appeal to the notion of shirking. What recommends the empirical part of our paper is its ability to demonstrate that the postulated wage-setting behavior is strongly supported by the data across a diverse spectrum of economies, and that the empirical regularity reported in Blanchflower and Oswald (op.cit) is also supported by both the model and the data.

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APPENDIX

Table I

Variables Used to Estimate Equation [32]

Variable	Definition
LN(ω)	Natural logarithm of the wage rate. The wage rate ω is defined as the average real wage expressed in 1996 purchasing power parity divided by the annual hours worked per employee. The wage rate is taken from Marquetti (2004) and the hours data come from Groningen Growth and Development Centre and the Conference Board (2006).
LN(Schooling)	Natural logarithm of the average schooling years in the total population in the age group over age 25. Source: Barro and Lee (2001).
LN(Rep. Wage)	Natural logarithm of the replacement wage. The replacement wage is a product of the wage rate ω defined above and the average gross unemployment benefit replacement rate sourced from OECD, Tax-Benefit Models available at www.oecd.org/els/social/workincentives.
(u/(1-u))	Unemployment-to-employment ratio defined as a difference between total labor force and total employment divided by total employment. Source: OECD Population and Labour Force Statistics.
Additional variables used as instruments in the endogeneity tests	
Government	General government final consumption expenditure (% of GDP). Source: World Development Indicators.
Fertility	Fertility rate, total (births per woman). Source: World Development Indicators.
ESI	Economic Security Index. Source: International Labor Organization (2004).

Table II

Sample Composition and Variable Averages

	Starting Date[1]	Number of observations	LN(Wage Rate)	LN(Schooling)	LN(Rep. Wage)	u/(1-u)
Australia	1965	33	2.3809	2.3026	0.8400	0.0630
Austria	1969	30	2.3943	2.0668	1.0860	0.0293
Belgium	1964	35	2.4561	2.0992	1.5687	0.0855
Canada	1964	34	2.4444	2.2852	0.6866	0.0847
Denmark	1964	35	2.4562	2.2336	1.5979	0.0614
Finland	1964	35	2.1548	2.0641	0.5521	0.0647
France	1971	27	2.5096	1.9476	1.3390	0.0873
Greece	1965	33	1.5625	1.8627	-1.0267	0.0609
Ireland	1964	35	1.9422	2.0166	0.5181	0.1162
Italy	1964	35	2.3080	1.7265	-1.5180	0.0923
Japan	1964	35	1.8016	2.0968	-0.4386	0.0218
Netherlands	1976	23	2.7096	2.1322	2.0453	0.0841
New Zealand	1976	8	2.3939	2.4267	1.1310	0.0247
Norway	1964	29	2.3798	2.0931	0.4114	0.0234
Portugal	1975	21	1.7717	1.2981	-0.0815	0.0715
Spain	1964	33	2.0378	1.6279	0.6074	0.1345
Sweden	1965	32	2.5639	2.1927	0.8106	0.0354
Switzerland	1964	30	2.6877	2.1975	-0.2371	0.0058
USA	1964	33	2.6703	2.3921	0.5318	0.0644
United Kingdom	1964	33	2.2820	2.0999	0.7727	0.0672
Sample		609	2.2874	2.0566	0.5155	0.0658

[1] Note that variables which have been lagged in the regression equation start at an earlier date.

Table III

Empirical Determinants of Ln(ω)

	Fixed Effect Panel		**Random Effect Panel**		**Fixed Effect Panel with Time Dummies**	
	(1)	(2)	(3)	(4)	(5)	(6)
Constant			1.3117***	1.3115***		
			(0.2015)	*(0.2000)*		
LN(Schooling)	0.2271**	0.2262**	0.2987***	0.2963***	0.3292***	0.3185***
	(0.1090)	*(0.1079)*	*(0.1009)*	*(0.1000)*	*(0.0915)*	*(0.0913)*
LN(Rep. Wage)	0.2166***	0.2212***	0.2000***	0.2049***	0.1886***	0.1923***
	(0.0535)	*(0.0531)*	*(0.0528)*	*(0.0524)*	*(0.0442)*	*(0.0441)*
LN(Schooling) × LN(Rep. Wage)	-0.0972***	-0.1009***	-0.0890***	-0.0929***	-0.1064***	-0.1082***
	(0.0266)	*(0.0264)*	*(0.0263)*	*(0.0261)*	*(0.0220)*	*(0.0219)*
u/(1-u)	-0.7580***		-0.7679***		-0.8645***	
	(0.0266)		*(0.1723)*		*(0.1531)*	
u/(1-u)_Lag		-0.9459***		-0.9505***		-0.8856***
		(0.1753)		*(0.1744)*		*(0.1548)*
Trend	0.0238***	0.0245***	0.0230***	0.0238***		
	(0.0013)	*(0.0014)*	*(0.0013)*	*(0.0013)*		
R-square	90.99%	91.13%	90.70%	90.85%	94.35%	94.36%

Note: The standard errors are given in parentheses. To conserve space the fixed and random effects, as well as the coefficient on time dummies are not reported. ***, ** denote statistical significance at 1% and 5% level, respectively.

Table IV

Results of Endogeneity Tests

Panel A. Results of the Davidson and MacKinnon (1989, 1993) Tests			
Instrumented Variable	Instruments	t-stat	p-value
LN(Schooling)	Fertility, Government, Lagged LN(Schooling), ESI, LN(Rep. Wage), u/(1-u), Trend, 19 Country Dummies	0.1634	0.8703
LN(Rep. Wage)	Lagged LN(Rep. Wage), ESI, LN(Schooling), u/(1-u), Trend, 19 Country Dummies	-0.1058	0.9158
LN(Schooling)× LN(Rep. Wage)	(Lagged LN(Schooling) × Lagged LN(Rep. Wage)), LN(Schooling), LN(Rep. Wage), u/(1-u), Trend, 20 Country Dummies	0.3017	0.7630
u/(1-u)	Government, Lagged u/(1-u), ESI, LN(Schooling), LN(Rep. Wage), Trend, 19 Country Dummies	-0.6346	0.5259

Panel B. Results of the Wu-Hausman Test			
Instrumented Variables	Instruments	χ^2-stat	p-value
LN(Schooling), LN(Rep. Wage), LN(Schooling) × LN(Rep. Wage), u/(1-u)	Government, Fertility, Lagged LN(Schooling), Lagged u/(1-u), Lagged LN(Rep. Wage), (Lagged LN(Schooling) × Lagged LN(Rep. Wage)), Trend, 20 Country Dummies	3.9240	0.4164

Table V

The Data Utilized in the Regression Reported in Table VI

Variable	Definition
w	The (average) wage rate $\equiv$ [the wage share in (GDP)]x[(GDP) per worker]. The source for the wage share is the Extended Penn World Tables 4.0 .The source for GDP per worker is the Pen World Tables 7.0.
eq	The education quality $\equiv e^{ERSI}$: where ERSI= Estimated Returns to Schooling of Immigrants in: Schoellman (2012).
u	The average rate of unemployment: Source: UNECE (United Nations Economic Commission for Europe).
q-1	The marginal cost of investment $\equiv$ {(price level of investment)/(price level of GDP)}. Source: PWT 7.0.
(K/N)	Capital per worker $\equiv$: (K/Y)/(Y/N). The source for (K/Y) is EPWT 4.0 and the source for (Y/N) is the PWT 7.0

Table VI

Empirical Determinants of Ln(w) in a Cross-Section Regression

Variable	Estimates
Constant	-0.4430
	(2.2757)
eq	0.0908
	(2.4819)
(eq)(u)	57.9024**
	(25.4645)
u	-63.7102**
	(27.8876)
ln(q-1)	1.4116***
	(0.2499)
ln(K/N)	1.0829***
	(0.0513)
Number of obs.	45
F(5, 39)	287.74
Prob(*F*-stat)	0.0000
R^2	0.9665
Root *MSE*	0.2038

Standard errors are in parentheses. Countries included in the regression are (1) Algeria (2) Australia (3) Austria (4) Belgium (5) Bolivia (6) Botswana (7) Canada (8) Chile (9) Colombia (10) Costa Rica (11) Cote D'Ivoire (12) Denmark (13) Egypt (14) Finland (15) France (16) Greece (17) Hong Kong (18) Ireland (19) Israel (20) Italy (21) Jamaica (22) Japan (23) Jordan (24) Korea, Republic of (25) Mauritius (26) Mexico (27) Morocco (28) Netherlands (29) New Zealand (30) Norway (31) Panama (32) Peru (33) Philippines (34) Portugal (35) South Africa (36) Spain (37) Sri Lanka (38) Sweden (39) Switzerland (40) UK (41) Trinidad & Tobago (42) Tunisia (43) Uruguay (44) USA (45) Venezuela

*, **, *** denote statistical significance at 10%, 5% and 1%, respectively.

Table VII

Empirical Determinants of Ln(Informal)

	(1)	(2)
Constant	-1.6793***	-0.9190***
	(0.0749)	*(0.3488)*
ln(q)	0.6233***	0.7178***
	(0.1477)	*(0.0965)*
Geography	0.5445***	
	(0.1829)	
Geography*ln(q)	-0.3607	
	(0.2392)	
Corporate Tax Rate		-0.0131
		(0.0114)
Individual Tax Rate		-0.0045
		(0.0049)
R-squared	0.4981	0.4220

Robust standard errors are in parentheses. *** denotes statistical significance at 1% level.